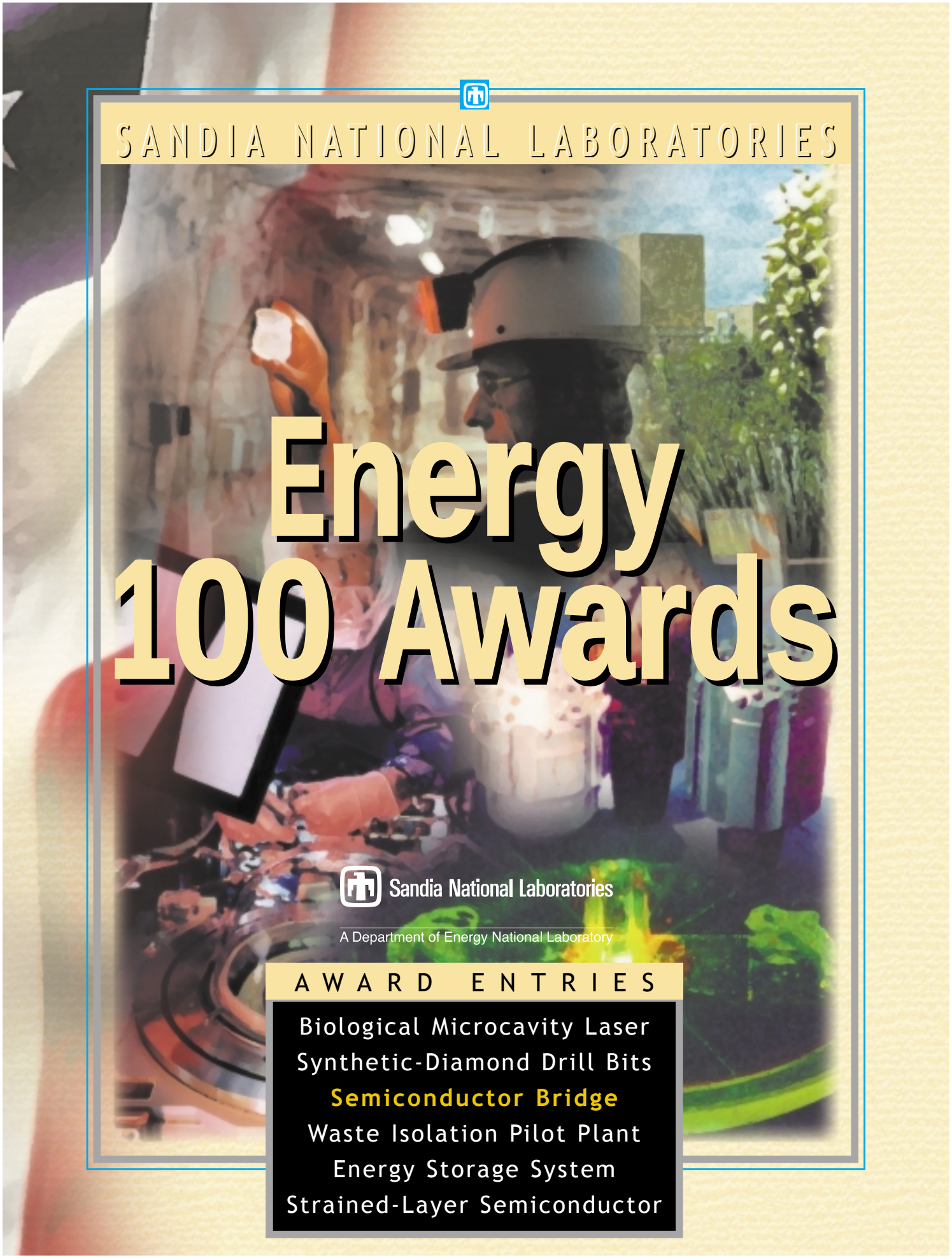
SANDIA NATIONAL LABORATORIES



Energy 100 Awards

Sandia National Laboratories

A Department of Energy National Laboratory

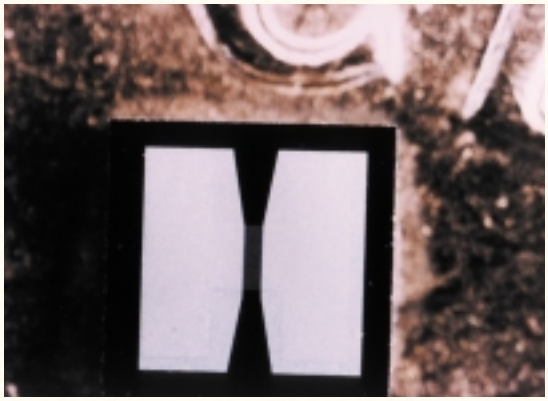
AWARD ENTRIES

Biological Microcavity Laser
Synthetic-Diamond Drill Bits
Semiconductor Bridge
Waste Isolation Pilot Plant
Energy Storage System
Strained-Layer Semiconductor

Semiconductor Bridge

Energy 100 Award Nomination
Technology: Explosives
Title: Semiconductor Bridge

Sandia National Laboratories
Submitted by: Lloyd Bonzon, Manager
Explosive Projects/Diagnostics
Phone: (505) 845-8989
e-mail: llbonzo@sandia.gov



The tiny semiconductor bridge sits atop a penny with the bottom of the "C" in the "Cent" partly visible.

ABSTRACT

Sandia National Laboratories developed a semiconductor bridge (SCB) igniter for a variety of explosive materials. SCBs offer vastly enhanced safety, performance, reliability, security, and weight and size savings for the nuclear stockpile. Today they also are being applied to precision conventional weapons for the same benefits. Their commercial applications in air bags and seat belt restraints, mining, construction, and oil and gas exploration and production have the potential to prevent hundreds of accidents or deaths, while saving consumers hundreds of millions of dollars. They also enable industrial applications that were impossible with other types of igniters.

1. Program Description

The goal of the U.S. Department of Energy (DOE) Manufacturing Development Engineering (MDE) program is to secure weapon components from industry instead of running its own—often more costly—manufacturing operation. Partnerships with a small Albuquerque, N.M.-based, SCB Technologies Inc., and Ensign Bickford Co. of Simsbury, Conn. (a leading supplier of explosives and detonation devices) are meeting that goal and enhancing the safety and reliability of explosive components used in national-defense weapons systems and in commercial and industrial applications.

The SCB was the first wholly owned patent (1987) granted to Sandia Labs. When subjected to a low-energy current pulse (less than 3 millijoules), the bridge bursts into an extremely hot plasma, causing rapid ignition of the explosive material pressed against the bridge. Despite the low energies required for ignition, SCB components are inherently safe, meeting both electrostatic discharge (ESD) and no-fire requirements. In addition, since heat transfer into the powder is a convective process, explosive outputs are obtained in only a few tens of microseconds. Finally, since SCB devices are processed using standard semiconductor-fabrication

techniques, circuitry on the same chip as the SCB can be incorporated for enhanced ESD and/or no-fire protection, precise timing delays, logic and/or for computer control.

These smart SCB devices are used for applications that include severe environments, precise timing for delays or sequencing, response to coded signals, and very-low energy inputs.

2. Improving Quality of Life

The safety, reliability, and security use control of the nation's nuclear deterrent has prevented a world-engulfing war for more than 50 years and will be the nation's primary strategic deterrent for many decades to come. The nation's economic and societal well being has been greatly enhanced by this period of non-catastrophic conflict. Maintaining the nuclear stockpile without testing requires weapon safety/reliability enhancements such as represented by the SCB.

In the harsh environment of aerospace and outer space, SCBs have functioned flawlessly in the Lightweight Targets Program; the lightweight targets were used in national missle defense flight tests. Here their low cost, weight, size, and energy requirements (in addition to their extreme reliability) have contributed to the success of this program and to the nation's defense.

Applied to the civilian sector, the SCB has saved workers from injury or death due to accidental detonations. An example from oil and gas production companies illustrates how SCBs save lives. These companies use explosive perforators in deep wells to create openings in the well linings so the oil or gas can flow into the well. Scores of oil-platform workers have been injured or killed when malfunctioning perforators were withdrawn and accidentally exploded at the wellhead. An SCB detonator built by Halliburton Energy Services eliminates the possibility of accidentally exploding perforators, thus saving lives while providing far greater accuracy in the perforations.

SCBs today allow much more precise geophysical surveys in a world of dwindling energy supplies. The Ensign-Bickford GEOSEIS™ Mini-Hole Seismic Blast Initiation System brings SCB precision to the seismic market. The SCB is far more precise than previous methods in setting off explosions that aid seismic explorations: The more accurate the timing on the explosions, the sharper and more powerful the seismic wave, and the better the data collected from return echoes. In 1997, this development won an R&D100 award.

With many present reserves of oil and minerals near depletion, exploration must find deeper reserves, or the nation's quality of life will suffer from energy and mineral shortages. Precision seismic technology is essential to this exploration.

3. Cost Savings

The SCB program at Sandia has produced cost savings without reducing stringent quality standards for the nuclear weapons program. But it is in the civilian sector that the nation sees the clearest cost savings.

The accurate SCB timing of GEOSEIS™ produces cost savings in conducting geophysical and mineral exploration with better results. Reducing accidents with explosive devices reduces medical costs and keeps wells producing. In addition, reducing prices at the wellhead by only a fraction of one percent saves the nation hundreds of millions of dollars. Towards that end, the Ensign-Bickford Co. is developing and using the SCB Digidet™ for precise timing for rock blasting and mining in order to obtain rubble with very uniform size.

Thus, mining companies will use these SCB devices to precisely maintain the size of chunks of ore fed to crushers. Crushers are used in virtually every mining operation to reduce ores to a fine powder for further refinement. The amount of electricity used by the crusher largely determines the cost of operation. Power companies charge operators on a monthly basis according to the highest amount of power used—the highest spike in the current drawn determines the entire month's billing. Therefore, more accurate measurements of the size of rubble fed to a crusher prevent these individual spikes in energy usage, saving operators millions of dollars a year.

4. Other Noteworthy Benefits

Last year, SCBs used in the Universal Water-Activated Release System (UWARS) helped save the lives of two Air Force pilots in a crash in the Gulf of Mexico by severing the parachutes from their ejection gear. UWARS (developed by Conax-Florida in conjunction with Sandia and Thiokol) is a relatively new system that saved lives in its first operational use.

In the near future, automobile-safety engineers envision a host of front, side, and top airbags as well as quickly tightening restraints to "cocoon" occupants in crashes. These safety devices may require 20 or more explosive devices per auto. Present conventional explosive igniters simply cannot meet design demand and economic requirements. However, the SCB will provide the safety, controllability, weight, energy, size, and cost savings needed to make these life-saving devices possible.

SUPPORTING MATERIALS

More information (including graphics showing the uniform wavefront possible with SCBs and success stories on transferring this technology to the civilian section) can be found at the Web site listed below and the accompanying articles.

Explosive Technologies Group Web Site: http://www.sandia.gov/explosive/projects/scb.htm

"Weapon Safety/Reliability Enhancements Are Main Goal of New Partnership Between Sandia Labs and the Ensign-Bickford Co.," Sandia National Laboratories, News Release, October 1997.

"The Semiconductor Bridge Igniter," *Journal of Pyrotechnics*, Issue No. 2, Winter 1995.

"A New Igniter for Air Bags?" *Manufacturing Technology*, August 1990.

"Semiconductor Bridge: A Plasma Generator for the Ignition of Explosives," *Journal of Applied Physics*," Sept. 1, 1987.